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Department of Defense (DoD) and industry - a healthy alliance.

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Monterey, California

THESIS

DEPARTMENT OF DEFENSE (DoD) AND INDUSTRY – A HEALTHY ALLIANCE

by

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June 2001

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This thesis explores the various practices and programs available throughout DoD to leverage resources and technology with industry. The collaborative methods of dual use technology and technology transfer and the contractual instruments that enable these methods and programs are discussed and evaluated where sufficient evidence permits. The most important programs are the Dual Use Science and Technology (DUS&T), Commercial Operations and Support Savings Initiatives (COSSI), Small Business Innovation Research (SBIR), Cooperative Research and Development Agreement (CRADA), and Technology Transfer. Innovation and collaboration between public and private industries are explored throughout the thesis with a focus on research and development. There is a lack of data needed to assess the effectiveness of these practices and programs.

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DEPARTMENT OF DEFENSE (DoD) AND INDUSTRY – A HEALTHY ALLIANCE

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B.S.B.A., Walsh College, 1987

Submitted in partial fulfillment of the
requirements for the degree of

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ABSTRACT

This thesis explores the various practices and programs available throughout DoD to leverage resources and technology with industry. The collaborative methods of dual use technology and technology transfer and the contractual instruments that enable these methods and programs are discussed and evaluated where sufficient evidence permits. The most important programs are the Dual Use Science and Technology (DUS&T), Commercial Operations and Support Savings Initiatives (COSSI), Small Business Innovation Research (SBIR), Cooperative Research and Development Agreement (CRADA), and Technology Transfer. Innovation and collaboration between public and private industries are explored throughout the thesis with a focus on research and development. There is a lack of data needed to assess the effectiveness of these practices and programs.

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ACRONYM LIST

ACC	Automotive Composites Consortium
ADCP	Advanced Display Core Processor
ADTT	Army Domestic Technology Transfer
ATP	Advanced Technology Program
BAA	Broad Agency Announcement
CAE	Computer Aided Equipment
CLS	Contractor Logistics Support
COMBATT	Commercially Based Tactical Truck
COSSI	Commercial Operations and Support Savings Initiative
CRADA	Cooperative Research and Development Agreement
DARPA	Defense Advanced Research Projects Agency
DFARS	Defense Acquisition Regulation Supplement
DOD	Department of Defense
DODGAR	Department of Defense Grant and Agreement Regulation
DOE	Department of Energy
DUAP	Dual Use Applications Program
DUS&T	Dual Use Science and Technology
FAR	Federal Acquisition Regulation
FTTA	Federal Technology Transfer Act
FY	Fiscal Year
FYDP	Future Years Defense Program
GAO	General Accounting Office

GDP	Gross Domestic Product
GOCO	Government-Owned Contractor-Operated
GOGO	Government-Owned Government-Operated
HMMWV	High Mobility Multipurpose Wheeled Vehicle
IDE	Integrated Data Environment
MPDP	Multi-Purpose Display Processor
NAC	National Automotive Center
NCRA	National Cooperative Research Act
NCTTA	National Competitiveness Technology Transfer Act
NIST	National Institute of Standards and Technology
OEM	Original Equipment Manufacturer
ORTA	Office of Research and Technology Applications
OT	Other Transaction
PLA	Patent Licensing Agreement
PNGV	Partnership for a New Generation of Vehicles
QDR	Quadrennial Defense Review
RDEC	Research, Development, and Engineering Center
SBIR	Small Business Innovation Research
SOW	Statement of Work
STTR	Small Business Technology Transfer
TACOM	Tank-automotive and Armaments Command
TAI	ThermoAnalytics, Incorporated

TIA	Technology Investment Agreement

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I. INTRODUCTION AND BACKGROUND

A. THE DEPARTMENT OF DEFENSE (DOD) ENVIRONMENT IN 2001

The congressionally-approved budget of the United States for Fiscal Year (FY) 2001 accounted for over $1.8 trillion in budget authority (the authority to obligate funds) with an estimated $1.835 trillion in outlays (estimated actual payments expected to be made). This budget, like the last two annual budgets, is balanced. In fact, based upon favorable economic indicators, surpluses are projected through FY 2005 and beyond.[1]

In support of our national security strategy, the Department of Defense (DoD) laid out a defense strategy and program which provides the basis for the FY 2001 budget and the Future Years Defense Program (FYDP). The FY 2001 defense budget continues implementation of DoD's FY 2000-2005 FYDP, which is the plan for ensuring America's security and global leadership. Both the FYDP and the new budget reflect the recommendations of the Defense Department's May 1997 Quadrennial Defense Review (QDR) as well as subsequent assessments of strategy, force structure, readiness, modernization, infrastructure and other determinants of the U.S. defense posture. In supporting the FYDP last year, the President made available to DoD $112 billion in additional resources over the FYDP.[2]

The FY 2001 national defense now represents slightly more than 16 percent of Federal expenditures, down from 24 percent in FY 1989 (the first post-Cold War year). More significant, however, is the decrease in defense costs as a percentage of gross

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[1] Fiscal Year 2001, Army Budget, An Analysis, Association of the United States Army, July 2000.

[2] Ibid.

domestic product (GDP), from more than 6 percent in FY 1986 (the highest percentage since 1972) to less than 3 percent in FY 2001 and continuing on a downward slope.[3]

According to DoD, the FY 2001 budget and the FYDP reflect a compromise between immediate military needs (most notably force readiness and quality of life) and long-term safeguards (most notably the development and procurement of new weapons and technologies). Prioritizing requirements that exceed available defense dollars remains a challenge and represents the environment DoD faces while trying to increase its technological superiority.

Achieving technological superiority requires sustained investments in each of the three budget activities that fund the science and technology program: basic research, applied research, and advanced technology development.[4] These budget activities represent the board categories of investments in terms of technical maturity and time.

The basic research program (6.1) exploits and identifies technological opportunities and provides an important interface with university and industry research. The applied research program (6.2) matures technology opportunities and evaluates technical feasibility for increased war-fighting capability. The advanced technology development program (6.3) demonstrates technologies to speed the transition of matured technology into a demonstration/validation program or directly into engineering and manufacturing development.[5] These research program dollars are stringent in the DoD

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[3] Fiscal Year 2001, Army Budget, An Analysis, Association of the United States Army, July 2000.

[4] Army Science and Technology Master Plan, 2001.

[5] Ibid.

environment in FY 2001; creative managers are seeking alternate and innovative ways to leverage research and development budgets, and reduce program costs.

The importance of Government and industry working together for mutual national benefit is not a new concept.

> Eisenhower, in his farewell address as President on January 17, 1961 noted the emergence of a permanent armaments industry of vast proportions in the United States and acknowledged the imperative need of industry and Government to manage it jointly. Today, the military-industrial complex – in Eisenhower's enduring phrase – is larger and more pervasive than he could have imagined. Linked by profit and patriotism, the armed services, corporations, scientists, engineers, consultants and members of Congress form a loose confederation that reaches almost every corner of U.S. society.[6]

In today's business environment, collaboration can increase the probability of gaining technologies, sharing the cost of technological research, and reducing the risk of being preempted by competitors.

Collaboration and joint ventures between public and private automotive agencies have grown out of pressing needs in the industry, military, and Government to drive down vehicle costs, increase technical sophistication, improve fuel efficiency, and increase safety. Industry and military collaboration started in the aerospace industry. The Automotive Composites Consortium (ACC) was formed in 1988. In 1990, a consortium formed between General Motors, Ford, Chrysler and the Commerce Department called 'USCAR' formed the Partnership for a New Generation of Vehicles (PNGV) and the U.S. Army formed the National Automotive Center (NAC). Both were

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[6] McCuen, Gary E., "Transforming the Warfare State – Global Militarism and Economic Conversion," McCuen Publications, Inc., 1992.

created to improve the cost and efficiency of vehicles and to develop a new class of vehicles without sacrificing key elements such as utility and safety.

The Army chartered the NAC in 1993 to be the Army's focal point for collaborative research and development with industry, academia and other Government agencies. Since 1993, the NAC has served as a catalyst linking Government, industry and academia. Bolstered by acquisition reform, organizations like the NAC have continued to refine the process by which ground military system needs are met through strategic partnerships with industry, academia and other Government agencies and by investments in state-of-the-art commercial automotive technology.

DoD should remain aware of trends that may impede its ability to maintain a technological edge. Maintaining a technological lead, requires stability in the science and technology budget, tracking commercial firms with technological leads in areas important to national defense, and awareness of international technological capabilities. DoD should continue to investigate new methods to accomplish its research and development goals.

B. COLLABORATIVE EXECUTION INSTRUMENTS

1. Dual Use Science and Technology (DUS&T)

The DUS&T Program was initiated in FY 1997 to increase the use of dual use technologies in defense systems as authorized by Public Law 104-201. The program has two primary purposes. The first is to jointly develop dual use technologies with industry. The second is to embed the concepts being developed under this and earlier dual use programs in the Services and to make the development of dual use technologies with

industry a standard way of doing business throughout the DoD. The second goal laid the groundwork for the transition of the program to the services in FY 1999, the first year the Services executed individual dual use science and technology program elements.[7] The DUS&T program is evaluated in further detail in Chapter II of this thesis.

2. Commercial Operations and Support Savings Initiative (COSSI)

COSSI is a program jointly shared between the U.S. Army, Navy, and Air Force, with the Office of Secretary of Defense providing administrative oversight. COSSI's mission is to leverage private sector research and development by inserting leading edge commercial technologies into fielded military systems to reduce operations and support costs.[8] Operational and support costs typically include all the costs of owning, operating, maintaining, and supporting a fielded DoD system during peacetime. This includes costs for personnel, consumable and repairable materials, organizations, intermediate and depot maintenance, facilities, and sustaining investment. Operational and support costs do not include the costs of developing, initially purchasing, improving the performance of, or disposing of fielded systems. Funding for COSSI was first provided in FY 1997, at which time it was part of the Dual Use Applications Program (DUAP) at the Defense Advanced Research Projects Agency (DARPA). Beginning in FY 1999, the funding for COSSI was directly appropriated to the Services.[9] The COSSI program is evaluated in further detail in Chapter III of this thesis.

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[7] DoD Guidelines for Dual Use Science and Technology Program Fiscal Year 2001, September 1999.

[8] Army Science and Technology Master Plan, 2001.

[9] COSSI Website: www.acq.osd.mil/es/dut/cossi/faqs.html.

3. Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR)

The purpose of DoD's SBIR and STTR programs is to harness the innovative talents of small U.S. technology companies for U.S. military and economic strength. DoD's SBIR program funds early-stage research and development projects at small technology companies which serve a DoD need and have the potential for commercialization in the private sector and/or military markets. The program, funded at approximately $560 million in FY 2000, is part of a larger ($1.2 billion) Federal SBIR program by ten Federal agencies.[10] The SBIR program allocations for FY 2001 are currently being submitted by the various Federal agencies, and are not yet available.

In 1992, Congress established the STTR pilot program. STTR is similar in structure to SBIR but funds cooperative research and development projects involving a small business and a research institution (i.e., university, Federally-funded research and development center, or nonprofit research institution). The purpose of STTR is to create an effective vehicle for moving ideas from our nation's research institutions to the market, where they can benefit both private sector and military customers. DoD's STTR program, funded at $31 million in FY 2000, is part of a larger ($62 million) Federal STTR program administered by five Federal agencies.[11] DoD issues one STTR research solicitation each year. The SBIR/STTR programs are evaluated in further detail in Chapter IV of this thesis.

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[10] DoD SBIR/STTR Website: www.acq.osd.mil/sadbu/sbir.

[11] Ibid.

4. Cooperative Research and Development Agreements (CRADAs)

A CRADA is a legal agreement between a Federal laboratory and a non-Federal party to conduct specified research or development efforts that are consistent with the missions of the Federal laboratory (15 USC 3710a(d)(1)). The Federal Technology Transfer Act of 1986 (Public Law 99-502) authorized Federal laboratories to enter in CRADAs (15 USC 3710a(a)(1)). Since that time, CRADAs have been a principal instrument for collaborative efforts. CRADAs are business, not procurement, contracts that allow the Government and industry to cooperate and share intellectual property resulting from joint efforts. CRADAs are only one of several mechanisms used for technology transfer. They make the technology, facilities, and people of laboratories available to commercial partners at an early stage of development; provide a direct benefit to the Services' mission from the partners' efforts; and, perhaps most importantly, encourage direct communication between scientists and engineers of the two sectors.

CRADAs are not a procurement, because the Government does not provide funding for services or products; therefore, military procurement procedures are not required. CRADAs are to be established to develop technology with obvious value, and should either commercially improve the U.S. competitive position or service the public good, as in health, education, or environmental areas. CRADAs are also sought in technology areas of strategic importance to laboratories or centers.[12] CRADAs were created as mechanisms to transfer technology from the Government to industry (spin-offs), and were not designed to efficiently or effectively transfer technology from

[12] Army Science and Technology Master Plan, 2001.

industry to the military (spin-on). The details of CRADAs are evaluated in Chapter V of this thesis.

5. Patent Licensing Agreements (PLAs)

PLAs are another important mechanism for commercializing inventions developed in Government laboratories. The PLA allows the transfer of less-than-ownership rights in Federal intellectual property to a third party, to permit the third party to use the intellectual property. PLAs can be exclusive or nonexclusive, for a specific field of use or geographical area.[13] Each laboratory maintains a collection of patents covering inventions by its scientists and engineers, and markets those inventions with potential commercial application. When licensed and commercialized, the inventions benefit consumers with new or improved products. Although PLAs serve an important role for mechanizing the opportunity for Government and industry to work together, this thesis will not discuss PLAs in further detail.

6. Technology Transfer

The Army Domestic Technology Transfer (ADTT) program seeks to create an environment that both fosters and facilitates the transfer of technology between military and civilian applications. The initial formal requirement for technology transfer from Federal laboratories was the Stevenson-Wydler Act of 1980 (15 USC 3701 et seq.). Its intent was to maximize the benefit of taxpayer investment in Federal research and development. The Federal Technology Transfer Act of 1986 (Public Law 99-502)

[13] PLA Website: www.crrel.usace.army.mil/partnering/Patents.html.

provided specific requirements, incentives, and authorities for Federal laboratories to engage actively in technology transfer. It gave the director of each Federal laboratory the authority to enter into CRADAs and to negotiate PLAs for invention made at their laboratories. Technology transfer will be discussed in Chapter VI of this thesis.

C. CONVENTIONAL CONTRACTS

Conventional contracts and grants require adherence to many Government regulations such as the Federal Acquisition Regulation (FAR), Defense Federal Acquisition Regulation Supplement (DFARS), or DoD Grant and Agreement Regulations (DoDGARs). In many instances, these instruments have proved too restrictive to attract industrial firms that are recognized technological leaders in their fields, either because of the management, accounting, or other regulations that apply, or the high cost to bid. Conventional contracting methods will not be a part of further evaluation in this thesis.

D. OTHER TRANSACTIONS (OTS)

OTs are authorized by 10 U.S.C. 2371. OTs are the most flexible contracting instrument because fewer regulations apply to them as compared to other instruments. OTs also allow return on investment for DoD. OTs can facilitate the Government's ability to take advantage of technological leads held by industry. When industry holds the technological lead, it may not be particularly eager to enter into a collaborative agreement that would let the Government exploit that lead. OTs are flexible enough to allow the Government to design an agreement in which its industry partner sees some financial advantages to entering into a collaboration. For example, the industry might be very interested in cost sharing.

The Government can also negotiate other terms that might "compensate" industry for Government exploitation of a technological lead. Industry might be persuaded by the Government's ability and willingness to negotiate particularly favorable joint-effort intellectual property rights. The flexibility of OTs include the waiver of almost all regulations that would force a prospective industrial partner to change its way of doing business. Exercising this feature can make the OT a powerful instrument for the DoD to use to attract industry into research and development partnerships.

E. NATIONAL TECHNOLOGY TRANSFER AND ADVANCEMENT ACT

The National Technology Transfer and Advancement Act of 1995 (Public Law 104-113) provides additional incentives, encouraging technology commercialization for both industry partners and Federal laboratory inventors. This law seeks to promote industry's prompt deployment of inventions created in a CRADA by guaranteeing the industry partner sufficient intellectual property rights to the invention and providing increased incentives and rewards to laboratory personnel who create the inventions.

F. RESEARCH AND TECHNOLOGY APPLICATIONS

Each Army laboratory and research, development, and engineering center (RDEC) has an Office of Research and Technology Applications (ORTA) to actively seek technology transfer opportunities and to serve as a point of contact for potential users of its technology. The functions of an ORTA include assessment of laboratory technology that might have commercial applications, assistance to state and local Governments, and development of programs in conjunction with private sector and laboratory technical and legal staffs. The programs are intended to work through the

decentralized but coordinated activities of the ORTA at each of the Army's laboratories and centers.

G. COLLABORATION BENEFIT ASSESSMENT

Prior to seeking a collaboration business relationship, it is important for program managers to understand industry's interest in a given technology. Without this information, it would be difficult for the DoD to ascertain whether it could find potential partners to perform research and development in the technology area. If a technology has many potential Government and commercial uses, then industry's interest is likely to be higher than if the technology had potential use for one defense Service only. Industry's interest in the former case is likely to be higher, since advantages in the technology have potential uses in many products or services. Hence, industry is likely to perceive such a technology as more likely to result in higher profits.

Collaboration offers a number of benefits to the DoD. For example, there are many firms that do not perform research and development with or for the DoD, but are doing leading-edge research and development in technologies of DoD interest. By collaborating with such firms, the DoD can exploit their technological leads and achieve technological advances both faster and cheaper. Partnering with industry can also introduce new sources of research and development money to the DoD through cost sharing. The DoD can also pool resources with industry to accomplish objectives that are too expensive to accommodate in its own research and development budget. In addition, collaboration can reduce the chance of duplicating work that has already been done by industry. The DoD may also be able to recoup some of its research and development

costs through recovery of funds, which is allowed under recently introduced instruments and programs described in later thesis chapters.

H. COLLABORATIVE DECISION MAKING

Program managers throughout the DoD have traditionally judged the progress and success of research and development efforts in terms of three benchmarks: performance, schedule, and cost.[14] Collaboration assessments can be judged on four different benchmarks: lead, initiate, participate, and monitor. When an organization chooses to lead, it defines the performance goals, provides the vision, and specifies the potential products or capabilities, as well as setting schedule requirements and outlining resource constraints. When an organization chooses to initiate an action, it can enter into a proactive search for a collaborating partner, and look for areas of intersection among its performance goals and those of potential industrial partners. These partners should have compatible schedules and have a negotiated set of resources available. When an organization participates, it may negotiate acceptable performance goals if it cannot find an appropriate intersection with industrial performance goals, and acceptable schedules and resource constraints are negotiable. The control of performance, schedule, and resources becomes a shared effort. When an organization chooses a monitoring role, two-way communication through informal means, such as working relationships, workshops, conferences, and seminars, is most prevalent.

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[14] Wong, Carolyn, "An Analysis of Collaborative Research Opportunities for the Army," Library of Congress, Published 1998 by RAND.

These collaborative management domains can be shown graphically as below. In Figure 1.0, industry interest is moderate to high in the right-hand region, suggesting that this is the general area where collaboration is likely to be most successful. The initiate, participate, and monitor domains lend themselves to collaborative management approaches. The identification of industry interest in the research and development of new technologies is a strong measurement of the potential success of a given program.

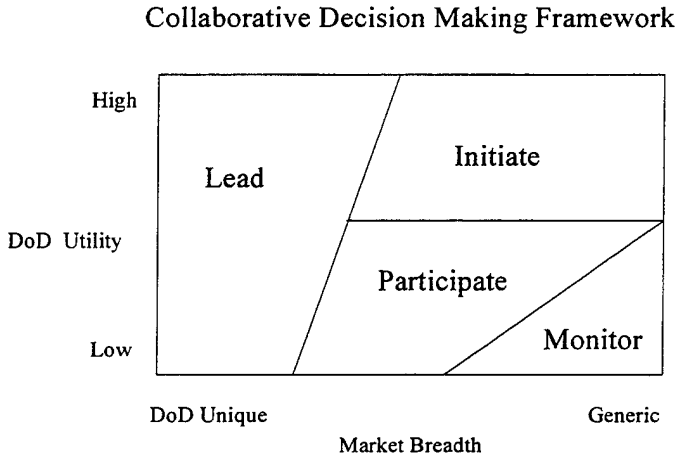

Figure 1.0

(Source: Wong, Carloyn, "An Analysis of Collaborative Research Opportunities for the Army," Library of Congress, Published 1998 by RAND)

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II DUAL USE SCIENCE &TECHNOLOGY (DUS&T)

A. SHARING TECHNOLOGY WITH AMERICA

For much of the period since the end of World War II, the scientific and technological efforts of the U.S. military establishment have set the pace for the American economy. The DoD has been a major financier of research and development as well as the largest purchaser and developer of new scientific applications. In the absence of explicit Federal technology policy, the practices of the Pentagon became, to a very large extent, the de facto U.S. technology policy.[15] Past spin-offs from military technology include computers, jet airliners, composite materials, communications equipment, and scientific instruments. For decades, many companies primarily oriented to civilian markets benefited from commercial use of spin-offs of high-powered defense research and development. For example, The Raytheon Company adapted radar technology to develop the microwave oven, and Boeing drew on its military aircraft design work on the B-47 and KC-135 in developing the 707 commercial airliner. Today's environment is one in which research and development is being conducted in both military and civilian sectors, with opportunity for both spin-off and spin-on.

In 1994, technical and business leaders in the U.S. chemical industry began a study of the factors affecting the competitiveness of the industry in a rapidly changing business environment and set out to develop a vision for its future. The work focused on

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[15] Weidenbaum, Murray, Small Wars Big Defense, Oxford University Press, 1992.

needs in research and development capabilities, which are directly linked to growth and competitive advantage.[16]

The study was also stimulated by a request from the White House Office of Science and Technology Policy for industry advice on how the U.S. Government could better allocate research and development funding to advance the manufacturing base of the U.S. economy. Since then, more than 200 technical and business leaders have investigated the challenges confronting the chemical industry today. The results of this work emphasize opportunities for advancement in research and development capabilities. Participants concluded that the growth and competitive advantage of the industry depend upon individual and collaborative efforts of industry, Government, and academia to improve the nation's research and development enterprise.[17]

B. THE CURRENT DUS&T PROCESS

The Dual Use Science & Technology (DUS&T) program was initiated in FY 1997 to increase the use of dual use technologies in defense systems. The program has two primary purposes. The first is to jointly develop dual use technologies with industry. The second is to embed the concepts being developed under this and earlier dual use programs in the Services and to make the development of dual use technologies with industry a standard way of doing business throughout the DoD. The second goal laid the

[16] National Technology Transfer Center, "Sharing Technology with America," Website: www.nttc.edu.

[17] Ibid.

groundwork for the transition of the program to the Services in FY 1999, the first year the Services executed individual dual use science and technology program elements.[18]

The elements critical to the success of the DUS&T program are industry cost share, which helps ensure the commitment of commercialization, and the use of Technology Investment Agreements (TIAs) (i.e., Other Transactions and Cooperative Agreements). The use of these instruments attracts commercial firms that might otherwise not be interested in doing business with DoD. The increased use of dual use technologies is essential to increase performance and sustainability and reduce the life cycle costs of defense systems.

The DUS&T program jointly funds research projects with industry for the development of dual use technologies to solve specific technical problems. A dual use technology is defined as a technology that has both military utility and sufficient commercial potential to support a viable industrial base. By increasing the use of dual use technologies in defense systems, the Services can take advantage of the same competitive pressures and market-driven efficiencies that lead to accelerated development and cost savings in the commercial sector. The key is to identify where the Services and industry have mutual interest and can work together to develop technologies that meet both defense and commercial needs. The program is accelerating the process by encouraging the implementation of dual use technology development projects in the Services.[19]

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[18] DoD Guidelines for Dual Use Science and Technology Program Fiscal Year 2001, September 1999.

[19] Ibid.

> Not only does dual use development make good economic sense for the nation, it is a crucial element in the DoD's drive to satisfy its military requirements in the face of declining resources. Performance at any cost must be replaced by affordable systems, whose costs are reduced by the volume production efficiencies allowed by complementary commercial applications of military technologies. The DoD must stimulate the development of military and commercial technology along parallel paths so that technology upgrades driven by dynamic commercial markets will be compatible with defense system application.[20]

FY 2001 is the fifth year of the DUS&T program. In previous years, approximately $190 million of DUS&T funds have been used to initiate over 200 dual use projects. The DUS&T funds, combined with Service and industry cost share, have resulted in an investment of over $700 million in the development of dual use technologies.[21]

C. MINIMUM REQUIREMENTS OF THE DUS&T PROGRAM

A dual use technology program is one that will meet a military need and have sufficient potential for a commercially viable production base. The term "dual use" refers to the character of a technology and/or product that has both military and commercial application. DoD's dual use strategy is an attempt by DoD to integrate the military technology and industrial base with that of the commercial sector by using more commercially available components in its systems or using commercial production lines to manufacture unique military components.[22] Many DoD procurement programs require low yearly production rates which result in decreased protection of the defense industrial

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[20] Davis, Lance A. Dr., "DoD Dual Use Technology and Technology Transfer," Army Research Development & Acquisition Bulletin, September – October 1995.

[21] DoD Guidelines for Dual Use Science and Technology Program Fiscal Year 2001, September 1999.

[22] Moteff, John D., "DoD's Dual Use Strategy," Congressional Research Service Report for Congress, Library of Congress, 95-322 SPR, March 2, 1995.

base. The DUS&T program can help corporations support and justify the low yearly production rates.

As the benefits of dual use technologies are shared, the cost of gaining these technologies must also be shared with DUS&T programs. Non-Federal participants must pay fifty percent of the total cost of the DUS&T efforts.

DUS&T awards to industry are intended to be based on competitive procedures and awarded solely on merit. This does not seem to represent a significant variation from traditional contract awards. Critics note that some of these programs with explicit concern for commercial markets stray too far from DoD's traditional programs which tend to focus exclusively on the military application of technology. Projects must result in the development of a technology, not the application of a technology.

During the first five years (1997-2000) of the DUS&T program, approximately 300 projects have been initiated with over $800 million invested by the DoD and industry to develop dual use technologies. The FY 2001 joint solicitation resulted in over 170 dual use science and technology proposals received for approximately $400 million worth of dual use technologies. The focus areas chosen by the services cut across the Services' mission areas and technology requirements and deal with electronics, medical, environmental and logistics applications.[23]

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[23] DTIC Website: www.dtic.mil/dust/proj.htm.

DoD announced the program in the area of DUS&T utilizing a Broad Agency Announcement (BAA) conducted jointly with the Army, Navy, and Air Force. The goal of DoD is to seek projects to create and/or develop new products or process technologies on a 50/50 cost share basis. The program requires that the proposed technology have military relevance and potential cost, performance or sustainability benefit, and sufficient potential commercial applications to support a viable production base. The BAA offeror must bear at least 50 percent of the cost of the effort and at least 50 percent of this cost share must be in the form of a high quality asset such as cash, labor or consumable materials. The proposer must be a profit company or have at least one profit firm on its team. Approximately $60 million of Federal funds will be available in FY 2001 for proposals in response to the BAA topic areas.[24]

In the spirit of acquisition reform, dialogue between proposers and the Government representatives is encouraged. Teaming arrangements, especially with academia, are encouraged when the result is a technically stronger proposal. Awards from the BAA are planned using a class of nonprocurement instruments called Technology Investment Agreements (i.e., Cooperative Agreements and Other Transactions).

D. DUAL USE PROGRAM DISTINCTIONS

Dual use programs are those science and technology programs that explicitly attempt to leverage the commercial sector's investment in those same technologies. A program that develops dual use technologies is not necessarily a dual use program, even

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[24] Ibid.

if it develops the same technology. Dual use technology programs typically involve consortia that include commercially oriented firms. The research agenda is negotiated with industry and aims to address the common needs of both the commercial and military sector. Industry cost-shares the project. The agreements are negotiated outside the Federal regulations for grants and contracts. This is particularly important because it frees firms from having to provide specified cost-and-accounting data and allows more flexibility in negotiating technical data rights. Both of these traditional Government policies have discouraged some commercially oriented firms from doing business with DoD in the past.[25]

E. DUAL USE TECHNOLOGY TECHNICAL AND MANAGEMENT ISSUES

In order for DUS&T proposals to be successful, a detailed explanation of the technical approach, objectives, staffing and resources related to the development of the proposal technology for both military and commercial use should be outlined. A technical description of the technology should offer a superior, innovative or unique solution to a military problem, challenge or need. The project must result in the development of a technology, not the application of a technology, and prototypes of the technologies are encouraged. Examples of work not funded under DUS&T include market studies, technology roadmaps, strategic plans, and state-of-the-art surveys. The technical description should include sufficient detail that provides clear, quantifiable

[25] Moteff, John D., "The Difference Between DoD Programs That Develop Dual-Use Technologies and DoD's Dual-Use Technology Development Programs—A Fact Sheet," Congressional Research Service Report for Congress, Library of Congress, 95-738 SPR, January 17, 1997.

technical objectives and a technical approach with a schedule showing definite decision points and endpoints.

The DUS&T proposal statement of work (SOW) should be suitable for inclusion or incorporation by reference in the TIA. The SOW should discuss the specific tasks to be accomplished with an explanation of the specific approach and goals of the project. In addition, personnel performing tasks should be identified whenever possible. A discussion that clearly lays out project risks and plans for dealing with them, including a statement of time-to-market considering available resources and the existing state-of-the-art, should be provided.

The project teams that include all the resources needed to successfully develop the technology and transition it to a defense team as well as to turn it into a commercial product or process should be explained. This team should be organized for efficient and effective execution of the project, with clear complementary roles for all members and clear lines of responsibility and authority in the management of tasks and cost control.[26]

F. DUAL USE BUSINESS ISSUES

DUS&T proposals should discuss the business issues that the proposer is facing and the proposed commercialization development activities. While a formal business plan is not required, the most readily accessible form for presenting a discussion of pervasive impact and commitment to production may be to provide a business plan. Projects should focus on technologies that will have a major impact on the cost, performance or sustainability of defense systems. In general, technologies that will have

[26] DTIC Website: www.dtic.mil/dust/proj.htm.

the greatest impact on the nation's defense, as well as those that will have a pervasive impact across a range of defense systems, will be rated higher.

The ultimate benefit of the product or process should be addressed. The objectives of the DUS&T program are to obtain the economies of scale, accelerated product improvements, and increased sustainability inherent in the commercial marketplace for defense procurements. It is essential that a commercialization path for the proposed technology be identified and that potential commercial applications be sufficient to support a production base that would be capable of meeting future defense requirements. A technology that would not be economically viable without significant military buys should not be considered.

The team's positioning to reach the intended commercial markets, and the specific advantages accruing from this effort should be explained. When lower cost is the basis for the competitive advantage of the proposed product or process, sufficient pricing data should be presented to permit evaluation of the claim. The market share and establishment of high quality job opportunities, and how the commercial value justifies the proposed Government investment should be addressed. The commitment to share the cost and risk of the proposed effort with the Government and industry should include high quality cost share (man-hours, materials, new equipment, restocking consumed parts), low quality cost share (wear-and-tear on in-place capital assets, overhead space utilization), and unacceptable cost share (sunk costs, bid and proposal costs, parallel research or investment).[27]

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[27] Ibid.

It is questionable if there are sufficient incentives to encourage innovative behavior at the program manager and contracting officer level who must implement the policy day-to-day. Much of the motivation behind reform is based on the assumption that the military industrial base is significantly segregated from the commercial base. The extent to which the base is segregated is unknown, and segregation can occur at three different levels: research, administration, and production. Although any savings may be sufficient to justify the dual use efforts being undertaken, it is difficult to know if the savings will be realized. There is skepticism that the Government can plan or execute programs to accelerate the commercialization of new technologies and products in an economically efficient manner.[28]

Some of the largest acquisition programs (e.g., tanks, submarines, and nuclear warheads) do not have parallel demand in the commercial market. Therefore, acquisition and program managers of these types of systems would not become overly dedicated to the DUS&T. There are, however, other types of systems (e.g., trucks and communications) that do have parallel demand in the commercial sector. In addition, there are components of unique military systems that could be dual use in nature.

Besides saving money by taking greater advantage of commercial production, proponents of integration believe DoD could also save money by relying more on the commercial sector to develop or co-develop new technologies and products of interest to both sectors. Military demands and commercial demands have dominated various technologies and products, and the leadership in demands will dominate the market.

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[28] Moteff, John D., "DoD's Dual Use Strategy," Congressional Research Service, Library of Congress, 95-322 SPR, July 3, 1997.

Industry dominance between the military and commercial sectors has changed over the years. For example, integrated circuits were initially developed with private capital, and military application drove further development and provided a critical early market. In the early 1960s, military and space procurement accounted for 90 percent of integrated circuits production. However, by the late 1960s, the commercial market began expanding much more rapidly. By the end of the 1970s, military procurement accounted for less than 10 percent.[29]

G. DUAL USE TECHNOLOGY SUCCESSES

The following are examples of dual use programs currently being accomplished.

1. Windchill

Product Development Company, PTC, and the Tank-Automotive and Armaments Command's (TACOM) National Automotive Center (NAC) have recently entered into a multi-million dollar two-year research and development, cost-sharing agreement for services and 4,000 licenses for PTC's Windchill software. PTC, acting as the prime contractor, will be working with a team comprised of General Dynamics Land Systems, Lockheed Martin Advanced Technology Laboratories, IITRI/AB Technologies, EDS, and Fakespace Systems to fulfill the U.S. Army's goal of fielding its Objective Force by FY 2008. Under the agreement, the NAC will use PTC's Windchill solutions as its Integrated Data Environment (IDE) across TACOM programs to support the Army's

[29] Moteff, John D., "DoD's Dual Use Strategy," Congressional Research Service, Library of Congress, 95-322 SPR, March 2, 1995.

vision of reducing the cost of developing next-generation transport and weapons systems. In addition, research and development efforts will focus on providing enhanced, immersive environment capabilities, web-centric project management solutions, and the development and deployment of a program manager IDE toolkit.[30]

2. 21st Century Truck

The 21st Century Truck program became a national initiative in April 2000 under the leadership of the Department of Energy, and represents a partnership effort with DoD, the Department of Transportation, the Environmental Protection Agency, and seventeen industrial corporations. These groups share a common DUS&T mission whereby coordinating research and development efforts and sharing results, significant achievements are planned for the trucking industry with regard to energy consumption, emissions, safety and performance.

The 21st Century Truck DUS&T initiative was proposed by the Army at the request of the DoD Under Secretary of Defense for Environmental Security, and in response to the Global Climate Change Initiative announced by the White House in October 1997. The DUS&T initiative plan was approved by the Assistant Secretary of the Army for Research, Development and Acquisition (now called the Assistant Secretary of the Army for Acquisition, Logistics and Technology) in September 1998. The initiative proposed an Army led, ten-year Government/Industry partnership to

[30] PRNewswire, Needham, MA, March 29, 2001.

significantly increase fuel efficiency, decrease emission, reduce total life cycle costs, and provide for safer 21st Century trucks for the military and commercial industries.

The Army received $15 million for the 21st Century Truck Program in FY 2001. Under the DUS&T initiative, this allows DoD to leverage not only the matching funds of the Army, but the other Government agencies and their matching funds. The initiative holds great promise for the Nation's environment and economy by reducing our dependence and consumption of petroleum-based fuels, shoring up the declining profit margin of our over-the-road transportation fleets and reducing the amount of greenhouse gases released into the atmosphere.[31]

H. OTHER CONSIDERATIONS OF THE DUS&T PROGRAM

"Defense spending contributes to the technology base not only through support of research but through procurement – and not only through technological artifacts like the integrated circuit, but through the development of engineering tools and design methodologies, as well as experience-based learning"[32] DoD concentrates dual use technologies in the research area, including the learning and design aspects of technologies.

A DUS&T assessment panel sponsored by all three military Services evaluated the program's progress in jointly funding the development of dual use technologies with industry and making this joint approach the normal way of doing business in the

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[31] U.S. Army Tank-automotive Research and Development Center, National Automotive Center, 21st Century Truck Initiative, Information Paper, January 18, 2001.

[32] Alic, John A., "Dual Use Technology: Concepts and Policies," John F. Kennedy School of Government, Harvard University, Cambridge MA, 1989.

Services. At the conclusion of the assessment, the panel found that if it is properly implemented, cooperative DUS&T development could play an important role in helping the DoD meet its science and technology objectives. The panel concluded that the set objective was being met.[33]

> The processes through which new technical knowledge makes its way into fielded military system and/or the civilian marketplace are lengthy and complex. In the absence of military secrecy, most of the barriers to diffusion from military to civilian sectors stem from the isolation of the defense industry. But barriers to the reverse flow, from civilian to military, are the more serious problems; they lie in the acquisition process.[34]

The DoD acquisition process has made many strides in reform during the last several years, such as eliminating unique military specifications and standards, cost, price data, and contractual requirements. DoD must continue to research efficiencies and continue to streamline the processes.

A principal element of DoD's effort to integrate the military and commercial technology and production base is acquisition reform. Acquisition reform seeks to remove regulatory barriers and internal DoD practices that inhibit program managers and contracting officers from acquiring commercially available products, or from producing military unique products on commercial production lines. Efforts to reform acquisition rules and regulations to encourage greater use of commercial technology in military systems have been around for many years, and remain crucial to attracting DUS&T partners.

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[33] U.S. Department of Defense, The DUS&T Particles, "Partnering with Industry for an Affordable and Effective Defense," Volume 1, Issue 3, April 2000.

[34] Alic, John A., "Dual Use Technology: Concepts and Policies," John F. Kennedy School of Government, Harvard University, Cambridge MA, 1989.

Reform is proceeding on two fronts, those associated with statutory requirements and those that are essentially internal to DoD. Statutory reform is represented by the Federal Acquisition Streamlining Act of 1994 (Public Law 103-355) and again in the Federal Acquisition Reform Act of 1996 (Public Law 104-106). These Acts have expanded the definition of commercial items, relaxed cost and pricing data requirements on commercial items, and made more flexible contractual requirements for commercial items. Internal reforms have focused mainly on military specifications and standards. A major policy directive is that all solicitation should use performance-based requirements and requires written justification for use of military specification. Another policy directive allows firms to adopt a single management system and uniform manufacturing practices for an entire manufacturing facility.[35]

The DUS&T program has been able to form mutually beneficial partnerships with foreign firms providing DoD access to their advanced technologies. At present, DoD has signed agreements with participants from the United Kingdom, Israel, and Canada. Thirteen foreign firms participate in the program as members of consortia or as subcontractors of U.S. firms. These include firms from Australia, France, Germany, and Norway. In 1998, the Republic of Korea established their own dual use program.[36]

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[35] Moteff, John D., "DoD's Dual Use Strategy," Congressional Research Service Report for Congress, Library of Congress, 95-322 SPR, July 3, 1997.

[36] U.S. Department of Defense, The DUS&T Particles, "Partnering with Industry for an Affordable and Effective Defense," Volume 1, Issue 4, July 2000.

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III. COMMERCIAL OPERATIONS AND SUPPORT SAVINGS INITIATIVE (COSSI)

A. THE CURRENT COSSI ENVIRONMENT

The Commercial Operations and Support Savings Initiative (COSSI) is another program jointly shared between the Services intended to leverage technologies developed in the commercial sector. COSSI's mission is to develop and test a method for reducing DoD operations and support cost by routinely inserting commercial items into fielded military systems. Many DoD systems will have to be maintained long beyond the useful life initially anticipated and planned. The extension of the service life of military systems causes the costs of DoD ownership to increase. The insertion of commercial items is expected to reduce DoD's operational and support costs by reducing the costs of parts and maintenance, reducing the need for specialized equipment, increasing reliability, and increasing the efficiency of subsystems. A fielded military system is one that has some current operational capability, and a system that is near the end of its useful life is not an appropriate target for COSSI. The best COSSI candidate will provide technology insertion that could increase component reliability, reduce the cost of spare parts and maintenance, and improve the efficiency of test equipment.[37]

Funding for COSSI was first provided in FY 1997, at which time it was part of the Dual Use Applications Program (DUAP) at the Defense Advanced Research Projects Agency (DARPA). Beginning with FY 1999, the funding for COSSI has been directly appropriated to the Services.[38]

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[37] COSSI Website: www.acq.osd.mil/es/dut/cossi.

[38] Ibid.

B. COSSI SNAPSHOT

COSSI provides "seed money" to insert leading edge commercial technology into legacy systems in an attempt to reduce total ownership costs, improve overall system readiness, and promote military and commercial integration. The general benefits of COSSI include increased mean-time-between-failures, elimination or reduction of parts obsolescence, and reduction of spare parts costs, software maintenance costs, testing time and effort. The COSSI program uses technology to make more money available for modernization, by reducing the need for funds to repair and sustain old equipment.[39]

C. FINANCIAL STATUS OF COSSI

To date, the COSSI program has provided funding for 60 projects with 18 projects selected for FY 2001. DoD has provided the COSSI program with $160 million, and industry has provided $117 million. There are over 100 participating contractors. The average DoD funding provided per COSSI program is $2.8 million. Program advocates state that an estimated operational and support cost reduction of $4 billion has been realized from COSSI efforts.[40]

The COSSI approach permits DoD to reduce its inventories, obtain rapid delivery from commercial suppliers, and upgrade through spares as new technology becomes available. COSSI solicits ideas from industry on ways to use commercial technologies. Once opportunities are identified, COSSI shares the costs of the nonrecurring engineering

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[39] COSSI Website: www.acq.osd.mil/es/dut/cossi.

[40] Ibid.

and qualification needed to adapt and successfully insert those commercially available technologies for use in a military system, graphically shown below.[41]

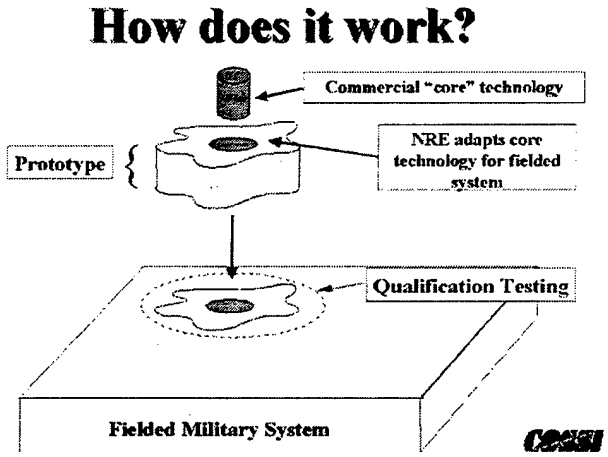

Figure 3.0

(Source: COSSI Website: www.acq.osd.mil/es/dut/cossi)

COSSI can be described as puzzle pieces of the total fielded system. As explained by Jacques Gansler, then Under Secretary of Defense for Acquisition and Technology, "COSSI – and similar efforts in the Army known as 'Modernization Through Spares' – help us to focus our attention on the fact that most of our early 21st century weapons will be those already fielded. Rather than simply replace subsystems or parts with the same historic items where required, we should instead insert modern elements (hardware and software) – preferably all commercial – which offer far greater reliability at far lower costs – yet with equal or, often, greater performance. Such actions will sustain the military usefulness of equipment, reduce support costs and improve

[41] COSSI Website: www.acq.osd.mil/es/dut/cossi.

readiness. For a small investment, the return is impressive. For a $100 million investment in COSSI last year alone, the expected savings are more than $3 billion over the next ten years."[42]

D. COSSI CONTRACTING

COSSI seeks proposals submitted by firms or teams that include at least one for-profit firm. Proposals must also include the written support of a "military customer" who has the authority to modify the system and purchase kits. To reduce the traditional administrative burden and oversight of Government contracts, Services using COSSI normally intend to use the innovative Other Transitions as the contracting instrument.

In selecting projects for funding, each Service will assemble a portfolio of projects that conform to the requirements of the solicitation and are determined to provide the best possible overall value. When two or more proposals are essentially equal, preference for award will be given to those proposals which include small businesses. COSSI efforts are intended to maintain equivalent system performance. The prototype must not degrade the performance of the fielded military system into which it is inserted. Any project that degrades the performance of the host system will be rejected. The following five selection criteria are used to evaluate proposals. The weighting of the criteria is shown in parentheses. A zero on any criterion can eliminate a proposal from further consideration.[43]

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[42] Gansler, Jacques S., "DoD Acquisition Reform: A Revolution in Business Affairs," Industrial College of the Armed Forces, January 23, 1998.

[43] COSSI Website: www.acq.osd.mil/es/dut.html.

- Operational and support savings (30%)
- Military customer commitment (25%)
- Technical and management approach (15%)
- Commercial leverage (15%)
- Non-Federal share of project costs (15%)

E. COSSI CONTRACTTING PHASES

COSSI is a two-phase process. Phase I is mainly dedicated to non-recurring engineering and qualification testing. This first stage usually lasts one to two years. Non-recurring engineering includes developing and implementing interface, environmental, or performance improvement. Phase I includes any qualification testing required to demonstrate that the kit will not degrade system-level performance and will produce the expected operational and support savings. The test results should help the military customer determine whether or not to proceed to Phase II. The proposer must contribute a percentage of the cost of completing Phase I, and there is no minimum cost share required.

If Phase I is successful, the military customer may then purchase reasonable production quantities of the kit in Phase II. Proposals must include target prices and projected quantities for kits in Phase II. Payment for the kits in Phase II and insertion into the fielded system is the responsibility of the military customer; therefore, the military customer must identify the source of funds that will be used to buy the kits in Phase II. The Services' goal in Phase II will be to purchase kits using sole source procurement procedures. In concert with acquisition reform, the proposal should

represent a fair and reasonable target price, and the proposer should not be required to provide detailed cost or pricing data.[44]

The involvement of the military customer, often the Service Program Manager, as a team member early in the process is critical to the program success.

> Bringing the Weapon System Program Manager into the COSSI program early, would have increased the likelihood of successful program initiation and continuation through Phase II commitment. It appears that the majority industry viewpoint is this: involvement of the program office as a COSSI program team member is the best assurance of program stability and will lower the risk of a Phase II not occurring.[45]

F. COST SAVINGS AND COST SHARING

Strong COSSI proposals will demonstrate large potential savings in operation and support costs within a 12-year analysis period. The repair costs for COSSI items should be compared with the costs for inventory items as added justification to warrant program initiation, and the measurement of cost savings is an integral part of the COSSI program. Cost sharing is a way for DoD to leverage its defense dollar. The flexible cost share of the COSSI program is a factor that could help attract competition.

G. COSSI SUCCESS STORIES

1. F-15E Open Systems Demonstration Project

The F-15E Open Systems Demonstration Project directly supports the application of commercial hardware and software technology to upgrade the F-15E Multi-Purpose

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[44] Program Description for the Commercial Operations and Support Savings Initiative, Announcement Number 00-94058, February 7, 2000.

[45] Ibid.

Display Processor (MPDP). The products of the Open Systems Demonstration Project are inputs to the DARPA funded COSSI project, "Commercially Based Processing for F-15E." The F-15 Program Office rated the upgrade of the F-15E MPDP as a "must do" because sustainability was a priority. The upgrade was a high priority because the MPDP had high levels of economic obsolescence, low reliability, and severe computer resource limitations.

As part of COSSI, the Boeing Company led an industry team to evolve a commercial multipurpose display processor, familiarly known as the Advanced Display Core Processor (ADCP). The effort to demonstrate the ADCP's ability to replace the MPDP and Very High Speed Integrated Circuit Central Computer while providing significant operations and support cost savings is the program goal. The ADCP is planned to enable critical operational capabilities and provide for efficient future growth. Program plans also include the investigation into the implications of applying an Open Systems Approach to the Programmable Communications, Navigation, and Instrumentation electronics package.

The Open Systems Demonstration Project results indicate that the current F-15 aircraft environment will support the insertion of commercially based hardware technology. Products of the Demonstration Project are being incorporated and implemented in the COSSI program and leveraged by other on-going F-15 and F-18 upgrade activities.[46]

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[46] F-15E Multi-Purpose Display Processor (MPDP) Upgrade, Executive Summer, PNUM 33.

2. Commercially Based Tactical Truck (COMBATT)

The COMBATT program is the result of an initiative that began in 1998 with an effort to develop the next generation of military vehicles with the participation of major automotive Original Equipment Manufacturers (OEM). It is a joint venture between DaimlerChrysler, Ford, AM General, and the NAC to develop a cheaper military truck for soldiers and a more advanced commercial truck for consumers. The COMBATT program provides a platform for the demonstration of advanced technologies in light and medium tactical vehicles, address special mission requirements and provide a possible platform for the next generation light tactical vehicles. COMBATT is one example of collaborative marketing, with creativity and invention necessary by-products of the recent trend toward joint research and development in the automotive world.[47]

Many High Mobility Multipurpose Wheeled Vehicles (HMMWV) are now approaching 20 years of age. The COMBATT program is designed to modify commercial pick-up truck missions currently assigned to the aging HMMWV fleet. COMBATT is expected to reduce the cost of developing and procuring new lightweight tactical trucks. The principle of turn-key fleet management by leasing vehicles for a 3-4 year period is being researched. Lease costs are minimized because of the relatively high residual value of vehicles. Operational and support costs are expected to be lowered with

[47] U.S. Army Tank-automotive Research and Development Center (TARDEC), "The Army's Implementation Plan to Accelerate the Infusion of Commercial Technology into Military Land Warfare Systems," March 1998.

the use of Contractor Logistics Support (CLS), because stock spare parts, repair manuals, or the training of mechanics will not be required.[48]

[48] U.S. Army Tank-automotive Research and Development Center, National Automotive Center Website: www.tacom.army.mil/tardec/nac.

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IV SMALL BUSINESS INNOVATION RESEARCH (SBIR)

A. THE SBIR PROGRAM

Public Law 106-554, Consolidated Appropriations Act of 2001, which contains the SBIR Reauthorization Act of 2000, was signed on 21 December 2000, extending the SBIR program until 30 September 2008. Execution of the SBIR program continues to be closely scrutinized by DoD and Congress.

The SBIR program makes capital available for high-risk projects at the earliest stages of development, typically before companies can attract venture capital or other sources of funding. Ten Federal agencies participate and each year more than $1 billion in SBIR contracts and grants are awarded to small firms to develop cutting-edge technologies. The DoD SBIR program is the largest in the Federal Government, awarding over $500 million annually to approximately 1,000 small high-technology companies. High technology has always been viewed with a mixture of excitement and caution by investors. Developing tomorrow's planar integrated circuit or supercomputer is risky business, but the SBIR program, while not taking the risk out of business, shares the cost of the adventure.[49]

DoD's SBIR program funds early-stage research and development projects at small technology companies, which serve a DoD need and have the potential for commercialization in the private sector and/or military markets. As part of its SBIR program, the DoD issues a SBIR solicitation twice a year, describing its research and development needs and inviting research and development proposals from small

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[49] Baron, Jon, "The Federal SBIR Program: Harnessing the Entrepreneurial Talents of Small Technology Companies," DoD SBIR Program Manager Report.

companies. The small companies are firms organized for profit with 500 or fewer employees, including all affiliated firms. Companies apply first for a six-month Phase I award of $60,000 to $100,000 to test the scientific, technical, and commercial merit and feasibility of a particular concept. If Phase I proves successful, the company may be invited to apply for a two-year Phase II award of $500,000 to $750,000 to further develop the concept, usually to the prototype stage. Proposals are judged competitively on the basis of scientific, technical, and commercial merit. In Phase III, small companies are expected to obtain funding from the private sector and/or non-SBIR Government sources to develop the concept into a product for sale in private sector and/or military markets.

Army scientists and engineers develop SBIR solicitation topics that address current and anticipated warfighting technology needs. Small businesses enter the SBIR process by submitting concepts in the form of Phase I proposals against these topics. SBIR is very competitive – about one in ten Phase I and one in three Phase II proposals are selected for award.[50] Phase III, the commercialization phase, is the goal of every SBIR effort.

B. SBIR HISTORY

The SBIR Program was initiated by Public Law 97-219 in July 1982. It was initiated to stimulate technological innovations, to use small business to meet Federal research and development needs, to foster and encourage participation by minority and disadvantaged persons in technological innovation and to increase private sector

[50] Department of the Army, The Army SBIR/STTR Program, A User's Guide, undated. Website: www.aro.army.mil/arowash/rt.

commercialization innovations derived from Federal research and development. The program was reauthorized by Public Law 102-564 in October 1992. Beginning with the FY 94-1 solicitation, the Office of the Director, Defense Research and Engineering, reviewed SBIR topics to assure that they had dual use as well as commercialization potential.

In its 16 years, the SBIR program has provided over 45,000 awards worth $8.4 billion in 1998 dollars to thousands of small high-technology companies. As the program has matured in the 1990s, Congressional concern has focused on private industry's ability to commercialize the results of the joint research. Another Congressional concern is that there has been a concentration of awards in certain states and companies. These states and companies are often referred to as "frequent winners" of the SBIR program.[51]

From FY 1983 through FY 1997, the 25 most frequent winners received over $900 million, or about 11 percent of the program's awards. These companies represent fewer than one percent of all the companies that have received awards. The programs have a high number of first-time participants. One-third of the companies receiving awards from FY 1993 through FY 1997 were first-time winners, indicating that the program is attracting hundreds of new companies annually.[52]

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[51] U.S. General Accounting Office, Report to the Committee on Science, House of Representatives, "Evaluation of Small Business Innovation Research Can Be Strengthened," GAO/RCED-99-114, June 1999.

[52] Ibid.

C. SBIR FUNDING

SBIR is funded by a set aside levied against all DoD research and development funding. In FY 1995, the set aside was two percent, which resulted in a $445 million SBIR budget. In FY 1997, the set aside was raised to two and one-half percent, and resulted in a $500 million SBIR budget.[53] Program managers with research and development budgets should plan ahead for this tax-levying process.

The expenditures of the SBIR program should span the scope of the economy's activities, because the missions of the sponsoring agencies vary extensively. The difference between SBIR expenditures and private funding is particularly salient for small firms. Perhaps one of the most puzzling observations about innovation by small technology-based firms is how concentrated it is among a small number of economic sectors. For example, venture capital financing has been targeted to a relatively narrow set of sectors, such as software development, telecommunications, biotechnology, and possibility automotive.[54] Many successful SBIR projects are associated with the industrial segments that attract the highest level of private financing and the level of political interest and constituency backing.

Program administrators may be incentivized to identify projects with the highest performance potential, and there may be political pressures to focus SBIR funding on those precise segments. On the other hand, the variety of agency mission may create pressures to provide beneficial effect of increasing the availability of funding to those

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[53] DoD SBIR/STTR Website: www.acq.osd.mil/sadbu/sbir.

[54] Gans, Joshua S., and Stern, Scott, "When Does Funding Research by Smaller Firms Bear Fruit?: Evidence From the SBIR Program," National Bureau of Economic Research, Inc., Working Paper 7877, September 2000.

segments of the economy where small-firm research corporations have technological challenges or capital constraints. "Through SBIR and other similar programs, we now know that the best ideas don't necessarily come from the labs of large corporations or even our Government labs. Most often, innovative technologies are invented by creative individuals at small, entrepreneurial companies."[55]

D. SBIR AND INNOVATION

The DoD goal to procure market-tested products which are reliable, of high quality, and affordable can be achieved by working with small firms that quickly commercialize their SBIR technologies. Inventors get the benefit of developing their ideas, while working with a paying customer early on. SBIR funding does not cause the inventor to lose any intellectual property rights for developed new technology. "Small companies play an essential role in commercializing innovations. When innovation technologies are commercialized, the cost and availability of these technologies for military applications are significantly reduced, creating a dual benefit to the economy and Defense Department."[56]

E. THE SMALL BUSINESS TECHNOLOGY TRANSFER (STTR) FOCUS

The STTR program funds innovative technology developed by small business partnering with universities, Federally-funded research and development centers, and

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[55] Hoeper, Paul J., Assistant Secretary of the Army (Acquisition, Logistics and Technology), Excerpt from the 2000 U.S. Army Phase II Quality Awards Ceremony, August 22, 2000.

[56] Preston, John, Senior Lecturer, Massachusetts Institute of Technology, Published by the U.S. Office of Small and Disadvantaged Business Utilization in the Office of the Under Secretary of Defense, "The Next Dimension in Funding for High Technology: DoD Provides Funds To Inventors and Small Businesses."

other non-profit research institutions. Congress established STTR in 1994 as a companion program to SBIR, and both programs have the same objectives and processes.[57] The STTR programs provides up to $600,000 in early-stage research and development funding directly to small companies working cooperatively with researchers at universities and other research organizations. The SBIR program provides up to $850,000 in early-stage research and development funding directly to small technology companies.[58] STTR Phase I efforts can be up to one year in duration, for a maximum of $100,000, and Phase II efforts are two-year efforts for up to $500,000.[59]

F. SBIR/STTR "FAST TRACK"

Since October 1995, the DoD's SBIR and STTR programs have featured a "Fast Track" process for projects that attract outside investors who will match Phase II funding, in cash, contingent on the project's selection for Phase II award. DoD devised the SBIR "Fast Track" policy to make the system more attractive to private investors. Under this approach, DoD gives its highest priority in making Phase II awards to small companies that attract independent third-party investors, such as venture capital firms, and large companies. This policy enables third-party investors to leverage their investment dollars. The SBIR program will allocate up to $4 for every $1 of outside investment. At the highest rate, a third party investment of $187,500 would bring $750,000 from DoD.[60]

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[57] U.S. Army SBIR Commercialization, 1999.

[58] Ibid.

[59] U.S. Army SBIR Commercialization, 1999.

[60] Baron, Jon, "The Federal SBIR Program: Harnessing the Entrepreneurial Talents of Small Technology Companies," DoD SBIR Program Manager Report.

Projects that obtain such outside investments and thereby qualify for the Fast Track will (subject to qualifications described in the solicitation) receive interim funding of $30,000 to $50,000 between Phases I and II and are evaluated for Phase II award under a separate, expedited process. Selection for Phase II award will be received provided they meet or exceed a threshold of "technically sufficient" and have substantially met their Phase I technical goals. Consistent with DoD policy, this process should prevent any significant gaps in funding between Phases I and II for Fast Track projects, and result in a significantly higher percentage of Fast Track projects obtaining Phase II award than non-Fast Track projects.

Thus far, over 90 percent of projects qualifying for the Fast Track have received interim funding and been selected for Phase II award.[61] As of July 2000, 158 projects are on the Fast Track, and under these projects, $110 million in DoD SBIR funds has directly leveraged at least $50 million in matching cash from outside investors.[62] Many small companies have found the Fast Track policy to be an effective tool for leveraging their SBIR (or STTR) funds to obtain additional funds from outside investors. This is because, under the Fast Track, a small company can offer an investor the opportunity to obtain a match of between $1 and $4 in DoD SBIR (or STTR) funds for every $1 the investor contributes.

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[61] DoD SBIR/STTR Website: www.acq.osd.mil/sadbu/sbir.

[62] Ibid.

G. EXAMPLES OF SBIR SUCCESS

1. Savi Technology

Savi Technology, Inc. of Mountain View, California recently developed the industry's first radio computer tag, the "SaviTag," using a combination of Navy SBIR funding and private venture capital. The SaviTag is a radio transceiver with an embedded microcomputer that can be attached to military cargo containers, or any other crate or container used for transport, and will automatically track the container's location and contents. The SaviTag was developed with just $2.5 million in SBIR funding (three awards) and has become a central element in DoD's Total Asset Visibility effort. SaviTag has assisted the DoD effort to pinpoint the location and content of every plane, ship, tank, and cargo container in transit around the world. Savi has received military contracts to date totaling over $185 million, and DoD now uses the SaviTag in a large segment of its logistical operations, including almost all shipments into Bosnia.[63]

The SaviTag solves a very real problem for DoD. During Desert Storm, over half of the 40,000 cargo containers shipped to the desert, including $2.7 billion worth of spare parts, went unused. The Army has estimated that if an effective way of tracking the location and content of the cargo containers, such as the SaviTag, had existed at that time, DoD would have saved roughly $2 billion.[64]

The SaviTag also has major applications in the private sector particularly in the commercial trucking, rail, and shipping industries. Savi's sales to the private sector are

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[63] Ibid.

[64] Ibid.

projected to be $20 million this year, and are increasing rapidly, with important applications in the commercial trucking, rail, and shipping industries.[65]

2. ThermoAnalytics, Inc.

ThermoAnalytics, Inc. (TAI) is located in the Houghton County Renaissance Zone of the Upper Peninsula of Michigan. This tax free zone has provided an economic opportunity to develop and market new products by turning tax dollars into internal development projects. By partnering with Michigan Tech University, TAI has collaborated on research projects and utilization of graduate student resources.

Through the SBIR program, TAI has developed a Computer Aided Engineering (CAE) software tool using the latest software engineering practices and techniques. TAI's cross-platform functionality and object oriented programming allows the program to run on any computer with maximum capability of integration with third party tools. The products from TAI's SBIR projects have evolved into a core thermal solver capability that is being spun off for use in new commercial products being developed at TAI as well as several fielded military products used by the services. The funds from commercial sales and the derived projects from use of its core thermal solver technology have become the prime funding sources for the growth of TAI. Ford Motor Company said that working with TAI has resulted in a world-class software tool and the Army said

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[65] Ibid.

this tool will aid in the fast track acquisition process that the DoD is relying upon to stay technologically strong.[66]

[66] U.S. Small Business Administration, Fifth Annual 2000 Tibbetts Awards, Awardee Profiles, October 2000.

V THE COOPERATIVE RESEARCH AND DEVELOPMENT AGREEMENT (CRADA) PROGRAM

A. WHAT IS A CRADA?

A CRADA is a legal agreement between a Federal laboratory and a non-Federal party that allows both parties to conduct specified research or development efforts that are consistent with the missions of the Federal laboratory (15 USC 3710a(d)(1)). The Federal Technology Transfer Act of 1986 (Public Law 99-502) permits Government operated Federal laboratories to enter into CRADAs with other Federal agencies, units of state or local Governments, industrial organizations, large corporations, small businesses, public and private foundations, nonprofit organizations (including universities), consortiums, foreign organizations, and/or other persons.

The primary purpose and intention of the Federal Technology Transfer Act is to encourage the transfer of commercially useful technologies from Federal laboratories to the private sector and to make accessible unique technical capabilities and facilities. CRADAs allow Federal laboratories to work collaboratively with industry, with the aim of turning the Government's research investment into commercial products. In addition, they encourage direct communication between scientists and engineers of the two sectors.

CRADAs are structured to offer the non-Federal partner an opportunity to leverage its resources with those of the Federal laboratory by sharing the costs of research for the development of products. The non-Federal partner may provide funds, personnel, services, equipment, facilities, intellectual property, or other resources needed to conduct a specific research or development effort. The Federal laboratory may provide similar

resources but may not directly provide Federal funds to the non-Federal CRADA partner.[67]

The Government protects any proprietary information brought to the CRADA effort by the non-Federal partner. This provides a true collaborative opportunity. Federal scientists can work closely with their non-Federal counterparts, exchanging ideas and information while protecting company secrets. All parties can mutually agree to keep research results developed during performance of the CRADA confidential and free from disclosure through the Freedom of Information Act for up to five years.[68]

B. CRADA CONTRACTING ASPECTS

CRADAs are not procurement contracts or grants. The Federal Acquisition Regulation (FAR) and FAR Supplements are not applicable to CRADAs. A CRADA can be easy to establish and typically takes between 60 and 90 days to complete.[69] Once signed, each party pays for its own tasks under a flexible Statement of Work. Intellectual property developed under a CRADA belongs to the inventing partner. Often, the commercial partner also has the first option to license technologies developed on an exclusive basis.

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[67] CRADA Website: www.crrel.usace.army.mil.

[68] Ibid.

[69] National Automotive Center Website: www.tacom.army.mil/tardec/nac.

CRADAs should be established to develop technology with obvious value, and should either commercially improve the U.S. competitive position or improve public health, education, or environmental welfare. CRADAs should also be sought in technology areas of strategic importance to the laboratory or center. While the focus of the law is transfer of Federal technology, it is clear that such interactions expose Federal scientists and engineers to leading edge technology in the private sector, allowing for the "spin-on" of information to the Government as well as "spin-off" to the private sector.

CRADAs have been a principal instrument for collaborative efforts. CRADAs are business contracts that allow the Government and industry to cooperate and share intellectual property resulting from joint efforts. CRADAs are not procurement contracts, because the Government does not provide funding for services or products; therefore, military procurement procedures are not required.

C. THE CRADA BUSINESS PROPOSAL

The submission of CRADA proposals take on a common-sense business approach and open communication throughout the process is often encouraged. The exchange of information may be done by informal and formal discussions and correspondence between the potential CRADA partner and the Government. CRADA proposals should represent a business plan.

A typical CRADA proposal may include various sections. An executive summary should include a brief synopsis of the total proposal. Market research and analysis should explain any market assumptions used in the proposal. The economics of the business, e.g., pricing data, retailer discounts, anticipated volumes, expected rate of returns, gross

and operating margins over time, and the breakeven analysis should be discussed. The marketing plan portion of the proposal should focus on selling, promotion, placement and distribution. The research, design and development plans are usually a crucial proposal section. It should concentrate on the cooperative development, or further development, of the appropriate technology that will lead to commercialization of the technology. Manufacturing and operations plans should also be explained. This section should discuss the potential equipment and availability, facilities, production flow, quality control, order fulfillment, materials, staffing, and turn-around time on orders. Information on key employees, their experience and short biographies provide insight into the management team. The program schedule is usually an important aspect of any proposal and should include enough detail to explain the required timeline for initial production, capacity and optional rates. Critical assumptions and risks in which the management team has experience, with focus on critical responsibilities, contributions or actions expected to be required, should be explained. Relevant business and related experience can be provided and often contributes to the overall creditability of the proposal. The business financial statement from recent years could present information on expenses and expected business revenues of the CRADA commercialization.

D. CRADA CONSORTIA

A consortium can provide the means to solve interdisciplinary problems involving broad-based technologies by bringing together the U.S. Federal, industrial and academic communities. The National Cooperative Research Act (NCRA) of 1984 permitted the

forming of consortia.[70] A horizontal consortium is generally industry-wide, oriented designed to increase the industry's global competitiveness. A vertical consortium involves the collaboration of a private firm, its vendors and a Federal laboratory to advance the development of technologies having commercial application.

Since the enactment of the NCRA, a number of consortia have been formed to help facilitate the CRADA process.

1. American Textile Partnership

This partnership was established in 1992 with membership of over 2600 textile, fibers and fabricated products manufacturers.[71] Areas of interest include improved materials and processes, apparel automation, analysis, simulation, computer integration, environmental quality, waste management, and energy.

2. Computer Systems Policy Project

This consortia represents twelve of the largest U.S. computer makers: Apple, AT&T, Compaq, Control Data, Cray Research, Data General, Digital, Hewlett-Packard, IBM, Sun Microsystems, Tandem, and Unisys.[72] Technological areas of interest include gigabit networking, parallel programming tools and processing algorithms, simulation, and distributed operating systems and tools.

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[70] Lefort, Gary L., Cooperative Research and Development Agreements: Transferring Federal Technologies to the U.S. Marketplace, The Library of Congress, 1997.

[71] Ibid.

[72] Ibid.

3. National Center for Manufacturing Sciences

This consortium was established in 1986 as a non-profit organization with the objective of assisting the manufacturing industry in developing advanced environmentally conscious technologies.[73]

4. U.S. Advanced Battery Consortium

This group was established in 1991 and membership includes Daimler-Chrysler, General Motors, Ford, industry auto suppliers, and the Electric Power Research Institute.[74] Its objective is to develop advanced battery technology for zero-emission electric vehicles.

E. CRADA OUTPUTS

1. Number of Active CRADAs

Since 1998, there has been a leveling off of reported CRADA agreements. This leveling follows prior years of sharp increases. A drop in Department of Energy (DoE) agreements appears to be one of the reasons for the leveling. Beginning in 1996, DoE's Technology Transfer Initiative started phasing out through 1998. This can account for the drop in the number of DoE agreements. DoD has replaced DoE in recent years as the agency with the most CRADAs in operation.[75]

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[73] Ibid.

[74] Ibid.

[75] Morella, Constance A., Chairwoman Subcommittee on Technology, Prepared Statement before the House Science Committee Technology Subcommittee, "A Review of the Department of Commerce's Biennial Report on Federal Technology Transfer," May 23, 2000.

2. CRADA Projects Initiated

According to data from 1998 – 2000, the rate of CRADA formation across the agencies has leveled off. Some agencies have suggested that their laboratories may be reaching the saturation point in terms of their ability to perform additional work with industry partners at existing levels of appropriated funding.[76]

F. CRADA CHALLENGES

1. Licenses

Federal agencies and their industry partners often have trouble reaching an agreement on the handling of intellectual property. The priority of the industry often focuses on creating a competitive advantage while the priority of a Federal agency is often the accomplishment of their mission. These differences in priorities and perception may result in different attitudes toward the creation and disposition of intellectual property. It is often a challenge to determine if an invention should be licensed on an exclusive or non-exclusive basis. The agreement between the parties should include specific procedures that will be applicable to licenses, the treatment of pre-existing inventions that may be brought into a CRADA, and the CRADA legal provision for the confidential treatment of certain data.[77]

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[76] Ibid.

[77] Carnes, Kelly H., Assistant Secretary for Technology Policy, U.S. Department of Commerce, Prepared Testimony before the House Committee on Science Subcommittee on Technology, "Concerning the Department of Commerce Report Tech Transfer 2000: Making Partnerships Work," May 23, 2000.

2. Clarification of Agreements

CRADAs have been rejected in some situations, e.g., those appearing to be for the purpose of procurement. Although partnerships have reached agreements on a case-by-case basis, a more formal recognition of the CRADA flexibility could benefit potential participants. The formal recognition could include adopting "model" agreements that highlight the range of circumstances in which agreements may be used.

3. Domestic Manufacturing Requirements

Often a "substantial manufacture" requirement of CRADAs requires that products ultimately produced by the use of license technology be manufactured domestically. This requirement is often difficult for many companies to meet because of the global nature of their supply chains and the need to preserve flexibility and promote competitive advantages in the sourcing of their goods. The laws do not clearly specify the circumstance in which such requirements can be waived.[78]

4. State versus Federal Policies

CRADAs have not proven effective as a mechanism for helping meet the technological needs of the state laboratories. State policies and practices applicable to CRADAs and to the handling of intellectual property do not mesh well with Federal policies.[79] Such differences between Government agencies make partnering with

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[78] Ibid.

[79] Ibid.

industry more difficult and burdensome. Clarification and streamlining should be held to high common standards between the agencies if the goal is to increase or continue the use of cooperative agreements.

5. Importance of Patents and Licenses

Many signed CRADAs involve research and development that eventually leads to the development of new inventions. Innovative inventions often require patent protection or granting of Federal licenses to further develop technologies for commercial applications.[80] Legislative provisions governing Federally funded inventions and license agreements have been enacted to provide an environment in which mutual benefit from cooperative projects can be achieved. The Federal Technology Transfer Act (FTTA) of 1986 gave U.S. Federal Government-owned Government-operated (GOGO) laboratories the authority to enter into advanced agreements to grant a patent license for any invention developed under a CRADA. In 1989, the National Competitiveness Technology Transfer Act (NCTTA) was passed. The NCTTA granted U.S. Federal Government-owned Contractor-operated (GOCO) laboratories the same authority that the FTTA gave GOGO laboratories.

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[80] Lefort, Gary L., Cooperative Research and Development Agreements: Transferring Federal Technologies to the U.S. Marketplace, The Library of Congress, 1997.

6. Use of Independent Research and Development Funds

There has been some confusion as to whether independent research and development funds could be use by contractors in funding their portion of a CRADA.[81] In 1991, the U.S. Congress and DoD provided guidance that approved the use of independent research and development funds in CRADAs. This approval resulted in an amendment to the Federal Acquisition Regulation (FAR) in September 1992.

[81] Ibid.

VI TECHNOLOGY TRANSFER

A. BACKGROUND

The Stevenson-Wydler Technology Innovation Act of 1980 (15 USC 3701) established the transfer of Federal technology as a national priority. It required that each Federal laboratory with more than 200 scientists and engineers have an Office of Research and Technology Applications to act as an interface with state and local Governments and the private sector for technology transfer. The Federal Technology Transfer Act of 1986 (Public Law 99-502) amended Stevenson-Wydler to authorize Government-operated laboratories to enter into CRADAs with non-Federal parties, thus providing a viable mechanism for technology transfer. Congress found that Federal laboratories' developments should be made accessible to private industry, state and local Governments, and has declared that one of the purposes of the Act is to improve the economic, environmental and social well-being of the U.S. by stimulating the utilization of Federally-funded technology development by the parties.

B. INTEGRATION OF TECHNOLOGY TRANSFER

Federal technology transfer mechanisms have taken root throughout several Federal research agencies. Technology transfer is greatly influenced by the nature of an agency's science and technology mission and by the relevance of that mission to the interests of business. For example, the National Institutes of Health and the Agricultural

Research Service have technology transfer programs that work closely with the pharmaceutical, biotechnological, and agricultural business sectors.[82] Their agency missions of improving the public health and improving agricultural productivity are often achieved through the commercial development and use of their research. In other agencies, broader research missions and large laboratory systems produce a different approach to technology. The transfer and sharing of these technologies can help accomplish various business missions.

C. TECHNOLOGY TRANSFER TRENDS

In an attempt to determine if technology transfer has become an integral part of the Government and private laboratory culture, the General Accounting Office (GAO) has attempted to measure activity outputs. Most of the information collected to date measures agency activity levels in the technology transfer field. In accordance with the Government Performance and Results Act (GRPA), the collected information is essentially input and output data and does not directly address the more final outcomes and results of technology transfer attempts.[83] The GAO has acknowledged that the creation of appropriate outcome measures for technology transfer activities is required.

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[82] Carnes, Kelly H., Assistant Secretary for Technology Policy, U.S. Department of Commerce, Prepared Testimony before the House Committee on Science Subcommittee on Technology, "Concerning the Department of Commerce Report Tech Transfer 2000: Making Partnerships Work," May 23, 2000.

[83] Ibid.

1. Invention Disclosure Outputs

The number of inventions disclosed by Federal agencies has not increased markedly since 1987. However, the Department of Agriculture and the Department of Energy have had some slight increases.[84]

2. Patent Applications

The information concerning patent applications does reflect a significant increase in the patenting activities of the agencies following passage of technology transfer legislation. Following an early increase, patenting activity appears to have leveled off. The DoE and DoD are the most active in patenting, and this likely reflects the tradition of "defensive patenting" to protect sensitive techniques.[85]

3. Patents Issued and Patent Licenses Granted

Since 1987, there has been a sharp increase in the number of inventions licensed by Federal agencies. Licensing seems to be an essential element of laboratory activity which often leads to technology transfer. Data concerning licensing income suggests increasingly effective and productive licensing activities at laboratories, with revenues increasing more than ten times from 1987 – 1999.[86]

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[84] Ibid.

[85] Ibid.

[86] Ibid.

4. Licenses and Recording Mechanisms

There is some concern with the Government databases that record inventions and royalty rights for technology transfer opportunities. A review of more than 2,000 patents and 12 large grantees issued in 1997 determined that databases for recording the Government's royalty-free licenses were inaccurate, incomplete, and inconsistent and that some inventions were not recorded.[87] As a result, the Government is not always aware of Federally sponsored inventions to which it has royalty-free rights.

The primary benefits of the royalty-free licenses are that the Government can use the underlying research without concern about possible challenges that such use was unauthorized. Federal agencies and their contractors and grantees are not complying with provisions on the disclosure, reporting, retention, and licensing of Federally sponsored inventions under the regulations implementing the Bayh-Dole Act and Executive Order 12591.[88] The Bayh-Dole Act was intended to create a uniform patent policy for inventions resulting from Federally sponsored research and development agreements. If technology transfer opportunities through patents are to be maximized, there appears to be a need for the Government to improve, standardize, and streamline the invention reporting process.

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[87] United States General Accounting Office Report to the Chairman, Committee on the Judiciary, U.S. Senate, "Technology Transfer Reporting Requirements for Federally Sponsored Inventions Need Revision," (GAO/RCED-99-242), August 1999.

[88] Ibid.

D. ADVANCED TECHNOLOGY PROGRAM (ATP)

1. ATP Background

The Omnibus Trade and Competitiveness Act of 1988 (Public Law 100-418) established the ATP to support research that accelerated the development of high-risk technologies in public and private laboratories. The goal of the ATP is to bridge the gap between public and private research laboratories and the marketplace through innovation. ATP provides a mechanism for industry to extend its technological research and transfer activities. ATP attempts to provide both commercial and societal benefits.

ATP is a competitive cost-sharing program that has funded 468 projects at a cost of approximately $1.5 billion in Federal matching funds. As of December 1999, 236 projects have been completed.[89]

Through tax credits or direct public funding, the Federal Government supports research that has very broad social benefits, such as public health, energy conservation, and environmental protection. There is, however, continuing debate over whether the private sector has sufficient incentives to undertake research on high-risk, high-payoff emerging and enabling technologies without Government support.

Advocates of the ATP believe that the Government should serve as a catalyst for companies that have shared vested interest in national technological development. Cooperative companies are encouraged to undertake important new work that would not have been possible in the same time period without Federal participation. Critics of the

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[89] United States General Accounting Office, Resources, Community and Economic Development Division, Report Number GAO/RCED-00-114 Advanced Technology Program, April 24, 2000.

ATP view it as an industrial policy or the means by which Government rather than the marketplace picks the technological winners and losers.[90]

2. ATP Focus and Cost Sharing

ATP projects focus on the technology needs of American industry, not those of Government. Research priorities for the ATP are set by industry, based on their understanding of the marketplace and research opportunities. The ATP has strict cost-sharing rules. Joint ventures of two or more companies must pay at least half of the project costs. Large Fortune-500 companies participating as a single firm must pay at least 60 percent of total project costs. Small and medium-sized companies working on single firm ATP projects must pay a minimum of all indirect costs associated with the project. ATP does not fund product development. Private industry bears the costs of product development, production, marketing, sales and distribution.[91]

3. ATP Award Process

The ATP awards are made strictly on the basis of rigorous peer-reviewed competitions. Selection is based on the innovation, the technical risk, potential benefits to the nation and the strength of the commercialization plan of the project. ATP support is not intended to become a perpetual subsidy or entitlement. Each ATP project has

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[90] Ibid.

[91] National Institute of Standards and Technology Website: www.atp.nist.gov.

goals, specific funding allocations, and completion dates established at the outset. Projects are monitored and can be terminated for cause before completion.[92]

Proposals are evaluated by one of several technology-specific boards that are staffed with experts in their respective fields. All proposals are assured a technically competent review with overarching, multi-disciplinary technology experts. The ATP accepts proposals only in response to specific, published solicitations.

The ATP process has the inherent need to guard against conflicts of interest and to protect proprietary information. Both of these needs make it difficult for ATP to avoid funding research that the private sector may already be pursuing. Critics may view this as a serious potential for duplication of efforts.

4. Conflicts and Duplication with Private Sectors

The GAO recently reviewed the National Institute of Standards and Technology (NIST) ATP document entitled "Performance of Completed Projects," Status Report Number 1, dated March 1999 to determine whether the ATP funded projects similar to private sector projects.[93]

GAO chose three of the 38 reported completed projects, each representing the different technology sectors of biotechnology, electronics, and information. The three completed ATP funded projects were approved for funding in 1990 and 1992. The three projects reviewed included an on-line handwriting recognition system, a system to

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[92] Ibid.

[93] United States General Accounting Office, Resources, Community and Economic Development Division, Report Number GAO/RCED-00-114 Advanced Technology Program, April 24, 2000.

increase the capacity of existing fiber optic cables for the telecommunications industry, and a process for turning collagen into fibers for human prostheses use. GAO found that the projects did address similar research goals to those already funded by the private sector, thus adding to critics' concerns.[94]

E. TECHNOLOGY TRANSFER IMPROVEMENT NEEDED

1. Knowledge Management in the Laboratory

There is an increased emphasis placed on the effective generation and use of knowledge as a source of competitive advantage in the private sector laboratories. The Government laboratories need to match their industry colleagues in this regard and account for the knowledge resources. This knowledge base could be used to advance agency missions and provide potential new technologies with commercial application to the economy. Prior to communicating their knowledge, Government laboratories will have to understand the need for confidential treatment of some developments.

2. Identification of the Right Laboratory

It is often challenging to identify the right laboratory to help with specific problems. Many Federal agencies have put considerable effort into outreach programs designed to make their competencies known to industry. However, it often remains difficult for a business unfamiliar with the Federal laboratory system to look across agencies to find the laboratories that may have the expertise needed to address unique

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[94] Ibid.

problems. The Federal Laboratory Consortium attempts to meet this need through the Laboratory Locator service and its associated web sites.[95] Communication of the laboratory skills and programs is not an easy task. All efforts to simplify the process will enhance business opportunities.

3. Communication with Industry

Even in today's environment where information technologies are advancing at great speed, effective communication continues to be a management challenge. There is a need for the technology agencies of the Government and industry representatives to meet on a regular basis to identify and address barriers to collaboration and technological advances.

[95] Ibid.

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VII RECOMMENDATIONS AND CONCLUSIONS

A. ACQUISITION REFORM

Rapid advances in commercial technology combined with declining U.S. defense budgets have rendered DoD's traditional, defense-unique approach to technology development and procurement less affordable and less effective than in the past. In order to maintain our strong U.S. defensive superiority, it is critical that defense programs take advantage of cost-conscious, market-driven commercial production and leverage the investments in leading-edge process technologies made by private industry. It is also important that defense technologies and systems keep pace with the rapid product development cycles driven in critical areas by highly dynamic commercial sectors. Acquisition reform efforts throughout DoD have made improvements in streamlining the acquisition process and making collaboration with industry possible.

Acquisition reform has laid the foundation to make successful partnerships between the DoD and commercial industries possible. These reforms include the authorization of flexible contractual instruments, elimination of strict military standards, insertion of commercial capabilities, integration of military and commercial development and production, and investment in dual use technologies. The monitoring of our national security and related technology continues to be a priority issue throughout these reform processes.

B. COLLABORATION AND RESOURCE BENEFIT

Collaboration and partnering with industry can introduce new sources of research and development money to the DoD through cost sharing. For example, collaboration

can allow the DoD to leverage its scarce and decreasing research and development resources to more effectively and efficiently accomplish its objectives. The DoD can pool resources with industry to accomplish objectives that are too expensive for one source to develop. Collaboration can also reduce the potential duplication of work between DoD and industry. Collaboration may result in some auxiliary benefits, e.g., DoD could be exposed to ideas and approaches that could have a positive effect on the way requirements are identified. Collaboration might also result in new sources of supply for needed products and services.

In order to meet the goals of tomorrow's technologies, and to stretch the shrinking DoD research and development dollar, Government and industry must continue their efforts to work collaboratively and team together in innovative ways. In doing so, this researcher believes that several mutual goals and benefits will be obtained. Government and industry can generate and use new knowledge by supporting research and development focused on new technologies to develop more cost-efficient and higher performing products and processes.

The need to encourage the elimination of barriers to collaborative pre-competitive research by understanding legislation and regulations that allow companies to work together during the initial stages of development must be a priority of all Government and industry leaders. Taxpayers must encourage elected officials to improve the legislative and regulatory climate. Programs that emphasize performance rather than a specific method of regulatory compliance with consideration of cost, benefits, and relative risk should be the standard method of conducting business.

The Government should improve logistics efficiencies by developing new methods for managing the supply chain. Efforts to shape information technology and standards to meet industry's manufacturing and distribution needs must become a priority issue within DoD. Industry should consider their agility in manufacturing by planning manufacturing facilities capable of responding quickly to changes in the marketplace using state-of-the-art measurement tools and other technologies for design, development, scale-up, and optimization of production. Government and industry should work together to harmonize standards, where appropriate, by working within the U.S. and internationally, and with independent standards groups on nomenclature, documentation, product labeling, testing, and packaging requirements. DoD needs to continue to create momentum for partnering by encouraging companies, Government, and academe to leverage each sector's unique technical, management, and research and development capabilities.

C. MANUFACTURING AND GLOBAL PARTNERING

Manufacturers today face greater challenges than ever. Globalization has expanded the availability of new markets, while simultaneously spurring intense competition in all manufacturing sectors. New technologies enable us to design, build, distribute, and support new and improved products with speed and quality not to be believed just a few years ago.

At the same time, the proliferation of technology solutions to manufacturing business challenges has greatly increased the complexity of making good decisions, and the cost of making incorrect decisions. Competitive pressures are passed down the value

chain, making it increasingly difficult for small companies to avoid wild fluctuations in workload and produce at small profit margins with risks that are high. Technology has leveled the playing field to the point where a small advantage or a minor innovation can mean the difference between success and failure.

D. SBIR CONCERNS

The ability to move research into commercialization must be considered as part of the SBIR evaluation criteria as well as the actual commercialization. These measures of outcome must be reported as a means of program justification.

E. THE SPEED OF TECHNOLOGY

The challenge of technology is that it won't stand still, and that the technology integration is often difficult to achieve. Off-the-shelf solutions are usually less complicated than the real complexity of integration. Manufacturers who buy off-the-shelf systems usually find that the cost of integrating the new capabilities into their operations dwarfs the cost of the initial acquisition. Many smaller manufacturers buy off-the-shelf packages or opt for custom-designed systems tailored to their situation, then realize that the system does not have the flexibility to adapt to new requirements.

Many manufacturing sectors have developed strategic plans to define a path to the future for their industry, and identify technology advances that will help them reduce costs, increase productivity, improve quality, shorten time-to-market, respond to regulatory drivers, and better serve their customers and other stakeholders. Strategic management can be a valuable tool to assure that investments are well placed. However, many of these roadmaps identify infrastructure issues as major barriers to progress, but

there has been little concerted attempt to attack these barriers with the intensity required for success.

F. RESEARCH AND DEVELOPMENT

One of the most significant connections between military and commercial technology development occurs at the level of research and development. It is important to determine whether research and development conducted for one sector is relevant to the other and how effectively technologies can be developed and utilized by various industry sectors. Although many dual use technologies can be identified that are vital to both military and commercial activities, other areas of technology do not find equally strong support in both sectors. For example, DoD is heavily involved in the aerospace and electronic industries, but not very involved in the chemical industry. Barring significant changes in its mission, DoD would not be expected to be the focus of progress in many areas of technology important to the commercial economy.[96]

G. INDUSTRY DETERRENTS FROM DOD DUAL USE PROGRAMS

It is not difficult to understand the reluctance of companies to invest in solutions that benefit everyone. Resources are scarce enough without spending hard-earned capital on activities that do not offer a direct and measurable improvement in the private industry bottom line for the next quarter or the next fiscal year. However, the benefits of infrastructure collaboration are obvious when one looks at the big picture. Total package solutions can be expensive to purchase and maintain, and often lock in proprietary

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[96] Epstein, Gerald L., "Competitiveness, Security, and Dual Use Technologies," John F. Kennedy School of Government, July 18, 1989.

strategy for years to come. There is much to be done to achieve total and complete collaboration between industries and Government, but the rewards will justify the effort.

Commercial interest in long-term exploratory research is typically less than DoD interest. DoD dual use programs tend to address technologies and technical issues with relatively near term application, i.e., within three to five years. The time frame gap between DoD and industry must be mutually agreed upon as jointly beneficial.

Stringent cost and accounting standards and non-ownership of technical data rights are two traditional Federal regulation requirements that typically dissuade commercial firms from forming partnerships with DoD.[97] These requirements must continue to be reformed while the protection of national security and data rights are protected.

Philosophical and psychological barriers may still exist as barriers to dual use technology. Pre-acquisition reform regulations and conservative mindsets can be barriers to dual use partnering. The use of taxpayer's dollars is often under extreme scrutiny, and perceived private industry benefit can easily raise public opinion questions. Improvement in the competitiveness of U.S. firms can strengthen the nation as a whole, thus providing benefit to taxpayers. The psychological barriers that lead to the non-acceptance of continued acquisition reform polices need to continually be addressed by committed DoD and corporate leadership.

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[97] Moteff, John D., "The Difference Between DoD Programs That Develop Dual-Use Technologies and DoD's Dual-Use Technology Development Programs – A Fact Sheet," Congressional Research Service for Congress, Library of Congress, 95-738 SPR, January 17, 1997.

H. CONCLUDING REMARKS

Defense spending contributes to the technology base not only through support for research and technological military systems, but also through procurement and the development of engineering tools and design methodologies. These combined efforts contribute to complete dual use partnering environments.

Military and commercial technologies are diverging in some cases, but not others. Even as military systems push the boundaries of performance, technical knowledge can find its way into the civilian market. DoD must be aware of and open to potential civilian applications, even those that are not obvious at the on-set of development.

The traditional processes through which new technical knowledge makes its way into fielded military systems and/or the civilian marketplace are often lengthy and complex. Acquisition reform has made great strides to allow the flow from military to civilian sectors as well as the reverse. Innovation with acquisition reform must continue to focus on efficiency and effectiveness in the acquisition processes.

Several years of budgetary stringency make it imperative that the DoD strive to design and develop weapon systems that take advantage of existing technology with complete understanding of complex integration issues.

I. ANSWERS TO RESEARCH QUESTIONS

The following primary and subsidiary research questions were addressed in the course of this study. Each question and a brief answer are provided below.

1. What methods, policies, and programs have been established to create an environment in which DoD might form alliances with industry?

The Dual Use Science and Technology Program is one means to increase the utilization of dual use technologies in defense systems. The Commercial Operations and Support Savings Initiative is a program that focuses on leveraging private sector research and development by inserting leading edge commercial technologies into fielded military systems. The Small Business Innovation Research and Small Business Technology Transfer programs attempt to harness the innovative talents of small U.S. technology companies for military application. The Army Domestic Technology Transfer program seeks to create an environment that transfers technology between military and civilian applications.

2. What contracting means are available to allow Government and industry to share and jointly develop information and technologies?

A Cooperative Research and Development Agreement is a legal agreement between Federal and non-Federal laboratories to conduct specified research and development efforts. Other Transactions are flexible contracting instruments that allow the Government to design an agreement in which its industry partner can achieve financial benefits from entering into a collaborative partnership.

3. How does the Government and industry decide if there is mutual benefit in the collaborative environment?

Performance, schedule and cost benchmarks can be used to determine if mutual benefit from a collaborative environment can be achieved. Organizations can further assess if their main role in the collaborative partnership should be one of leadership, initiator, participant or monitor.

J. SUGGESTED FURTHER RESEARCH TOPICS

One suggested research topic is the outcome measurement of collaborative execution within a given period of time. Further research could include the detailed infrastructure, management, and outcome of collaborative consortia. The DoD prioritization of technology development and transfer with industry would also lead to further research opportunities.

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